

# Shelf and Bathyal Bivalve and Scaphopod Mollusks from the Sea of Japan by KT-11-9 cruise of the R/V *Tansei-maru*

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**Abstract** Thirty-one species of bivalves and two scaphopods were identified in the molluscan collection trawled by the R/V *Tansei-maru* from 25 stations (142–1564 m depth) scattered over the northern, central and western parts of the Sea of Japan. Three species, namely, *Nuculana acinacea*, *Limopsis kurilensis*, and *Musculus minutus* are the first records to the Sea of Japan. Among bivalves, the most frequent species was *Nuculana robai* from 16 stations (813 specimens) followed by *Megayoldia toyamaensis* from 10 stations (122 specimens). The most abundant species was *Acila mirabilis*, 1070 specimens (from 3 stations) followed by *Nuculana robai*.

**Key words:** Sea of Japan, bathyal, shelf, bivalves, scaphopods.

## Introduction

Since an intensive benthic faunal survey was carried out in the western sector of the Sea of Japan by the T/V *Tanshu-maru* during 2009 to 2011 (Fujita, 2014), more trawl sampling at 25 stations scattered over the entire Sea of Japan was executed by the R/V *Tansei-maru*. The geographical coverage by the R/V *Tansei-maru* survey was the northern (Musashi-tai Bank, and off Esashi, Hokkaido), central (Toyama Bay and off Noto Peninsula) and western (off Kasumi, Hyogo Prefecture) sectors of the Sea of Japan, at depths ranging from 142 m to 1564 m.

The results of identification of bivalves and scaphopods sorted out from the benthic samples will supplement the past information offshore bathyal bivalve and scaphopod faunae of the Sea of Japan hitherto reported, such as Ito (1967, 1979), Tsuchida and Hayashi (1994), Tsuchida and Hori (1996), and Okutani and Saito (2014) for the western sector, Kuroda and Kikuchi (1933), Kikuchi (1936), Kuroda (1957), Ito

(1981, 1985, 1989), Ito *et al.* (1986) for Toyama Bay and Sado Island–Niigata area, Okutani and Izumidate (1992) for Yamatotai-Bank, as well as the northern area along the coast of Primorye (Lutaenko, 1999; Kamenev, 2013; Lutaenko and Northworthy, 2012, 2013) among others.

## Materials and Methods

**Collecting gears.** The gear used for this survey on the R/V *Tansei-maru* was the ORE-type beam trawl, with a 3 m mouth width (Fujita, 2014). The position, date, and depth of the positive stations for the present material are shown in Table 1 and plotted in Fig. 1.

**Format.** Under the entry of “Material examined” forerunning the scientific name and Japanese name (Jn) or newly proposed Japanese name (n. Jn), station number prefixed by E- (off Esashi, west coast of Hokkaido), K- (off Kasumi, Hyogo Prefecture), M- (Musashi-tai Bank), N- (north off Noto Peninsula), and T- (Toyama Bay), respectively, for indication of general area of sur-

Table 1. Collection data relevant to R/V *Tansei-maru*, KT-11-09 cruise.

Stn.	Date	Position in	Position out	Depth (m)	Locality
M-1	27 May 2011	44°43.78'N, 140°05.79'E	44°43.12'N, 140°05.44'E	152–166	Musashi-tai Bank
M-2	28 May 2011	44°40.48'N, 140°02.38'E	44°39.53'N, 140°02.83'E	198–206	Musashi-tai Bank
M-3	28 May 2011	44°37.21'N, 139°56.68'E	44°36.29'N, 139°57.82'E	413–407	Musashi-tai Bank
M-4	28 May 2011	44°35.38'N, 139°52.93'E	44°34.32'N, 139°53.70'E	608–627	Musashi-tai Bank
M-5	28 May 2011	44°31.41'N, 139°47.13'E	44°29.91'N, 139°47.96'E	1035–1080	Musashi-tai Bank
M-6	28 May 2011	44°16.68'N, 139°36.85'E	44°14.25'N, 139°37.25'E	1461–1421	Musashi-tai Bank
E-1	29 May 2011	41°52.01'N, 139°33.90'E	41°52.94'N, 139°34.33'E	247–222	Off Esashi
E-2	29 May 2011	41°50.26'N, 139°34.03'E	41°48.70'N, 139°34.18'E	388–538	Off Esashi
E-3	29 May 2011	41°47.46'N, 139°34.49'E	41°48.96'N, 139°34.88'E	635–563	Off Esashi
E-4	29 May 2011	42°03.91'N, 139°40.11'E	42°03.38'N, 139°39.98'E	787–802	Off Esashi
T-1	31 May 2011	37°28.45'N, 137°28.15'E	37°29.16'N, 137°27.86'E	160–173	Toyama Bay
T-2	31 May 2011	37°28.77'N, 137°29.07'E	37°29.53'N, 137°28.63'E	207–258	Toyama Bay
T-3	31 May 2011	37°29.18'N, 137°33.25'E	37°29.35'N, 137°31.96'E	383–443	Toyama Bay
T-4	1 June 2011	37°19.80'N, 137°33.38'E	37°20.02'N, 137°34.20'E	562–574	Toyama Bay
T-5	1 June 2011	37°18.45'N, 137°31.77'E	37°18.66'N, 137°32.85'E	794–790	Toyama Bay
T-6	1 June 2011	37°28.29'N, 137°45.89'E	37°26.70'N, 137°44.59'E	1488–1564	Toyama Bay
N-1	1 June 2011	37°54.59'N, 136°56.92'E	37°54.51'N, 136°58.43'E	162–157	Off Noto Pen.
N-2	1 June 2011	37°57.06'N, 136°56.60'E	37°57.04'N, 136°58.23'E	203–203	Off Noto Pen.
N-3	1 June 2011	38°03.25'N, 136°53.39'E	38°03.82'N, 136°55.13'E	403–414	Off Noto Pen.
N-4	1 June 2011	38°08.04'N, 136°49.64'E	38°09.00'N, 136°51.20'E	617–604	Off Noto Pen.
K-1-2	3 June 2011	35°43.89'N, 134°28.04'E	35°43.11'N, 134°28.98'E	142–144	Off Kasumi
K-2	3 June 2011	35°46.11'N, 134°30.94'E	35°46.57'N, 134°32.09'E	204–204	Off Kasumi
K-3	2 June 2011	35°54.85'N, 134°18.60'E	35°55.17'N, 134°20.08'E	411–370	Off Kasumi
K-4	2 June 2011	35°59.92'N, 134°20.58'E	35°59.61'N, 134°18.82'E	611–613	Off Kasumi
K-5	2 June 2011	36°22.25'N, 134°23.61'E	36°20.18'N, 134°22.84'E	1290–1277	Off Kasumi

vey, and number of specimens with range of shell length (both in parenthesis), registration number of the National Museum of Nature and Science, molluscan collection (NSMT-Mo) are recorded only for live-taken specimens. Dead, empty shells or detached valves were not included. If any, some observations and taxonomic comments on the specimens are all given under “Remarks”.

*Systematics.* The systematic arrangement of bivalves primarily follows Bieler and Mikkelsen (2006).

### Results: Taxonomy

#### Class BIVALVIA Linnaeus, 1758

#### Subclass Protobranchia Pelseneer, 1889

#### Order Nuculoida Dall, 1889

#### Family Nuculidae J. E. Gray, 1824

#### *Acila mirabilis* (A. Adams and Reeve, 1850)

[Jn: *Ö-kiraragai*]

(Fig. 3A, B)

*Material examined.* St. T-2 (340: 7.3–30.3

mm), NSMT-Mo 81001; St. T-3 (14: 5.8–28.9 mm), NSMT-Mo 81002; St. K-2 (716: 5.1–28.6 mm), NSMT-Mo 81003.

*Remarks.* Most of Japanese authors (*e.g.* Habe, 1961, 1964, 1977; Higo *et al.*, 1999; Okutani *et al.*, 1988; Kurozumi and Tsuchida, 2000; Okutani and Saito, 2009, 2014 *etc.*) applied the name *A. divaricata* (Hinds, 1843) for this species. However, Huber (2010) claimed that the true *A. divaricata* is not found in Japan, and Hinds' species, which was originally described from China, is a small species (20 mm >) with weaker ribbing and less rostrate posteriorly. Zhang *et al.* (2014) criticized the identity of both taxa on molecular basis and concluded that *A. divaricata* and *A. mirabilis* are distinct.

This species was fifth ‘most abundant’ and sixth ‘most frequent’ species among 29 bivalve species trawled by the T/V *Tanshu-maru* from the west off Oki Islands or northern coast of Shimane Prefecture in 2009 (Okutani and Saito, 2014). St. K-2 with 716 specimens collected by a single haul is located nearby the previous survey area suggesting that a large stock of this species

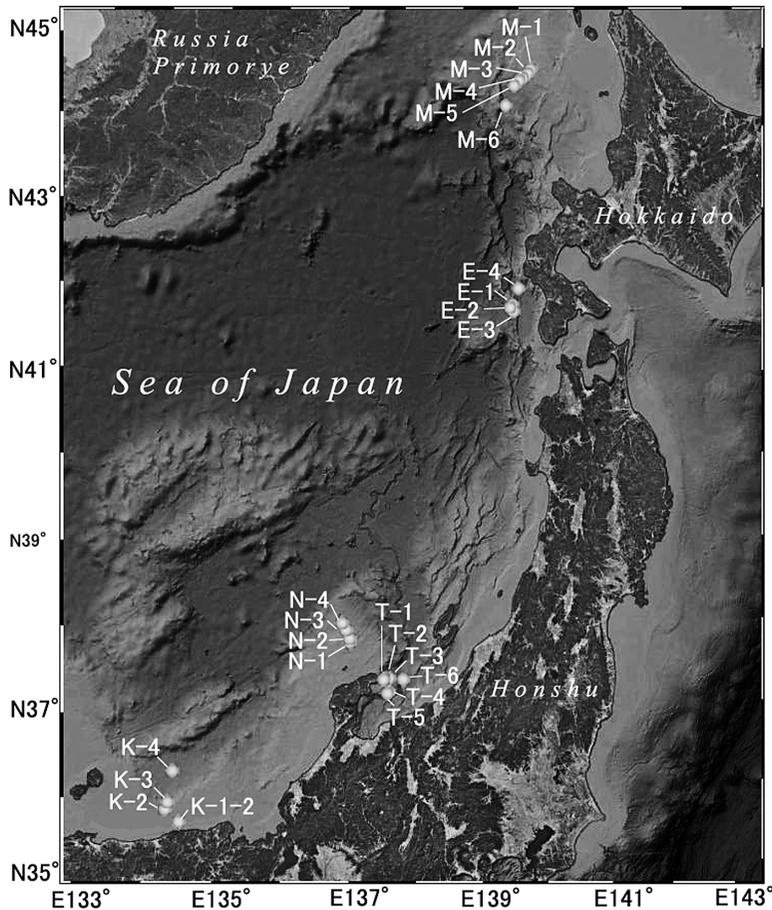


Fig. 1. Map of stations occupied by the R/V *Tansei-maru*, KT-11-9 cruise. This map was made based on Google Earth.

exists in that region.

***Ennucula tenuis* (Montagu, 1808)** [Jn: Kogurumigai]  
(Fig. 3C)

*Material examined.* St. M-3 (44: 4.4–8.9 mm), NSMT-Mo 81004; St. M-4 (30: 6.2–9.5 mm), NSMT-Mo 81005; St. M-5 (1: 8.8 mm), NSMT-Mo 81006; St. T-3 (14: 4.4–6.6 mm), NSMT-Mo 81007; St. T-4 (1: 4.1 mm), NSMT-Mo 81008; St. N-3 (8: 5.1–6.8 mm), NSMT-Mo 81009; St. N-4 (1: 3.2 mm), NSMT-Mo 81010; St. K-2 (7: 5.9–9.0 mm), NSMT-Mo 81011; St. K-3 (1: 6.7 mm), NSMT-Mo 81012.

*Remarks.* This species seems to be more frequent in bathyal depths around the Musashi-tai

Bank than elsewhere among the present material. This is the one of the representatives of the circum-boreal species occurring in the Arctic Sea, North Atlantic, the Bering Sea and Northeast and Northwest Pacific (Coan *et al.*, 2000; Scarlato, 1981). The bathymetrical range in the Sea of Japan by Kamenov (2013) is 10–1075 m, while that by Higo *et al.* (1999) for general distributional area is subtidal to 2200 m. Both show unusual bathymetrical ranges from very shallow waters down to upper abyssal depths suggesting that there may be cryptic taxa.

**Order Nuculanoida Carter,  
Campbell and Campbell, 2000**

Family Nuculanidae

H. Adams and A. Adams, 1858

***Nuculana (Robaia) robai* (Kuroda, 1929)** [Jn: Rōbai or Chirirōbai]  
(Fig. 3D)

*Material examined.* St. E-1 (1: 5.4 mm), NSMT-Mo 81013; St. E-2 (11: 8.1–13.5 mm), NSMT-Mo 81014; St. E-3 (214: 4.8–16.8 mm), NSMT-Mo 81015; St. E-4 (2: 12.1, 14.7 mm), NSMT-Mo 81016; St. M-3 (268: 1.3–15.6 mm), NSMT-Mo 81017; St. M-4 (144: 4.1–18.0 mm), NSMT-Mo 81018; St. M-5 (1: 16.4 mm), NSMT-Mo 81019; St. T-3 (28: 8.6–16.1 mm), NSMT-Mo 81020; St. T-4 (51: 6.7–16.6 mm), NSMT-Mo 81021; St. T-5 (18: 6.9–19.1 mm), NSMT-Mo 81022; St. T-6 (1: 16.5 mm), NSMT-Mo 81023; St. N-2 (1: 12.7 mm), NSMT-Mo 81024; St. N-3 (36: 8.6–16.1 mm), NSMT-Mo 81025; St. K-2 (17: 10.3–14.5 mm), NSMT-Mo 81026; St. K-3 (18: 8.8–12.9 mm), NSMT-Mo 81027; St. K-4 (2: 7.7, 9.2 mm), NSMT-Mo 81028.

*Remarks.* Kamenev (2013) considered that *Nuculana habei* Scarlato, 1981 is a junior synonym of this taxon. Huber (2010) also supports the view that *Robaia* Habe, 1958 is monospecific. Thus, this species seems to be confined to not only the Sea of Japan but also the Sea of Okhotsk, 83–2900 m depth (Kamenev, 2013).

This was the third ‘most abundant’ and second ‘most frequent’ species among bivalves in the previous study on the western Sea of Japan fauna (Okutani and Saito, 2014). The present data revealed that this species is extensively distributed from the northern sector of the Sea of Japan to the central and western sectors as well, suggesting that this nuculanid may play an important role for food source of bottom fishes living in this sea area.

***Nuculana acinacea* Habe, 1958** [Jn: Shakushirōbai]  
(Fig. 3E)

*Material examined.* St. N-1 (1: 7.4 mm), NSMT-Mo 81029; St. K-3 (10: 11.0–14.1 mm), NSMT-Mo 81030.

*Remarks.* This species is distinct from *N. pernula*, which is common in the Sea of Japan, in having the more slender rostrum bearing scale-like lamellae thereupon and concave dorsal margin. This species is more common on lower shelf of the Pacific coast from Sagami Bay southwestward to Kyushu (Habe, 1973; Kurozumi and Tsuchida, 2000; Okutani, 2006). The occurrence from the Sea of Japan seems to be unusual.

Family Yoldiidae Dall, 1908

***Megayoldia toyamaensis* (Kuroda, 1929)** [Jn: Toyama-sodégai]  
(Fig. 3F, G, H)

*Material examined.* St. E-3 (1: 19.1 mm), NSMT-Mo 81031; St. E-4 (1: 6.4 mm), NSMT-Mo 81032; St. M-3 (1: 19.9 mm), NSMT-Mo 81033; St. T-3 (34: 5.6–20.6 mm), NSMT-Mo 81034; St. T-4 (24: 5.4–29.6 mm), NSMT-Mo 81035; St. T-5 (7: 4.9–26.1 mm), NSMT-Mo 81036; St. N-3 (25: 4.5–25.8 mm), NSMT-Mo 81037; St. N-4 (17: 5.9–10.1 mm), NSMT-Mo 81038; St. K-2 (10: 7.3–11.2 mm), NSMT-Mo 81039; St. K-3 (2: 8.9, 10.5 mm), NSMT-Mo 81040.

*Remarks.* *Megayoldia* sp. of Kamenev (2013) from depth of 470–1300 m off Primorye is this species. This taxon has seldom been reported from outside of the Sea of Japan, but Higo *et al.* (1999) followed Habe (1977) that the distribution range of this species being from the Sea of Japan to the southern Kyushu via the East China Sea coast of Kyushu, 200–600 m depth. The voucher specimens collected from outside of the Sea of Japan are not accessible for the present study. Kurozumi and Tsuchida (2000) gave the distribution range as “Japan Sea, mud bottom, 200–500 m”.

It is worth noting here that the present material contains a number of youngs (the smallest specimen is 5.3 mm SL) that exhibit marked differences from larger specimens in shell morphol-

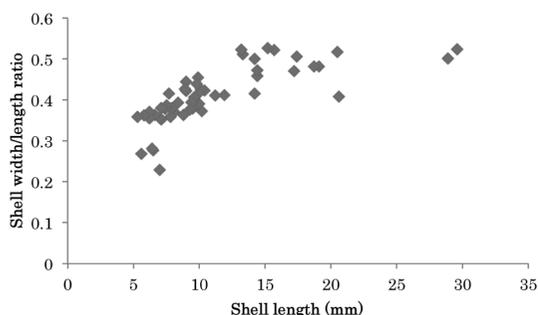


Fig. 2. Increase of shell width with growth in *Magayoldia toyamaensis*. n = 52, shell length from 5.3–29.6 mm.

ogy. In our measurement data from 52 specimens (NSMT-Mo 81034, 81035), whose SL from 5.3 mm to 29.6 mm, it appears that those youngs have less inflated shells: the ratio of SW to SL increases with growth, from 0.36 in the smallest specimen, 5.3 mm SL (lowest ratio is 0.23 in the specimen of 7.0 mm SL) to 0.52 in the largest specimen, 29.6 mm SL (highest ratio is 0.53 in the specimen of 15.2 mm SL) (Fig. 2). The young shells have shorter posterior prolongation resulting in more posteriorly (almost centrally) situated umbo (Figs. 3F, G, H). The identification of such small specimens has been rather difficult without availability of specimens representing sequential growth stages.

This species was second ‘most abundant’ and the ‘most frequent’ species among bivalves collected from off Oki Islands and Shimane Prefecture in the previous study (Okutani and Saito, 2014). The present investigation revealed that this species is more abundant near the type locality (Toyama Bay) and around Noto Peninsula than elsewhere, but is extended northward to the northern localities, such as St. E-3 (605–563 m depth) and E-4 (831–802 m depth) off Esashi, west coast of Hokkaido.

***Yoldiella kibi* (Kuroda, 1929)** [Jn: Kibi-sodégai] (Fig. 3I)

*Material examined.* St. E-3 (2: 3.0, 3.4 mm), NSMT-Mo 81041; St. E-4 (1: 1.6 mm), NSMT-Mo 81042; St. M-4 (24: 1.8–2.4 mm), NSMT-Mo

81043; St. T-3 (26: 1.6–2.5 mm), NSMT-Mo 81044; St. T-5 (6: 2.7–3.5 mm), NSMT-Mo 81045; St. N-3 (9: 1.8–2.0 mm), NSMT-Mo 81046; St. N-4 (9: 1.5–2.7 mm), NSMT-Mo 81047; St. K-4 (2: 2.8, 3.2 mm), NSMT-Mo 81048; St. K-5 (17: 1.2–3.1 mm), NSMT-Mo 81049.

*Remarks.* Kuroda (1929) described *Yoldia* (*Yoldiella*) *kibi* as a new species from Toyama Bay. But, later Habe (1977) synonymized it with a European fossil species, *Nucula philippiana* Nyst, 1844. The occurrence of conspecific species living in the bathyal zone of the Sea of Japan and from European (Belgium and Sicily) fossil communities seems to be improbable. Thus, here Kuroda’s name is preferably revived. *Yoldiella derjugini* Bartsch in Scarlato, 1981 is most likely synonymous.

This is not endemic to the Sea of Japan. According to Higo *et al.* (1999), this species is distributed in the Sea of Japan, Hokkaido and Suruga Bay, 40–2230 m depth. While, Coan *et al.* (2000) and Kamenev (2013) (both as *Y. derjugini*) reported it from the Sea of Japan, the Sea of Okhotsk, the Bering Sea to the Gulf of Alaska, 22–2520 m depth.

This species was the ‘most abundant’ and third ‘most frequent’ species among bivalves collected from off Shimane Prefecture in the previous study (Okutani and Saito, 2014 as *Y. philippiana*). The present investigation revealed that this species is extended northward to the northern localities, such as Sts. E-3 (605–563 m depth) and E-4 (831–802 m depth) frequently concurrent with the preceding species.

### Subclass Pteriomorphia Beurlen, 1944

#### Order Arcoida Stoliczka, 1870

##### Family Limopsidae Dall, 1895

***Limopsis tokaiensis* (Yokoyama, 1910)** [Jn: Ō-shirasunagai] (Fig. 3J)

*Material examined.* St. M-2 (1: 15.2 mm), NSMT-Mo 81050; St. M-3 (1: 20.6), NSMT-Mo



81051; St. T-2 (1: 22.6mm), NSMT-Mo 81052.

*Remarks.* A small specimen was collected that is similar to *L. crassula* Habe, 1953, which

was originally described from off Tsugaru Peninsula, northern tip of Honshu, at a depth of 123 m. However, it is easily distinguishable from *L.*

*crassula* in having no toothless area on the hinge plate, and no pit-like interspaces on shell surface generated by intercrossing raised growth lines with fine radial striae. Habe (1981) treated this species being synonymous with *L. tajimae* Sowerby III, 1914, which had been used in many of past works.

***Limopsis kurilensis* Scarlato, 1981** [n. Jn: Chishima-shirasunagai] (Fig. 3K)

*Material examined.* St. E-1 (5: 6.5–10.4 mm), NSMT-Mo 81053.

*Remarks.* These specimens are distinguishable from either the preceding species or *L. obliqua* A. Adams, 1863 by the smaller size, being slightly less inflated and less oblique, and having a smaller number of cardinal teeth. However, the difference between both species is so subtle that the relationship between them merits closer comparative study on many more specimens.

### Order Mytiloida Férussac, 1822

Family Mytilidae Rafinesque, 1815

***Modiolus margaritaceus* (Nomura and Hatai, 1940)** [Jn: Mamé-hibarigai] (Fig. 3L)

*Material examined.* St. T-1 (1: 7.6 mm), NSMT-Mo 81054; St. N-1 (2: 7.7, 14.1 mm), NSMT-Mo 81055; St. K-1-2 (16: 4.2–8.3 mm), NSMT-Mo 81056.

*Remarks.* This epibiotic mussel has seldom been collected in soft bottom habitats. In the previous survey (Okutani and Saito, 2014), a large population of this species was found attached on shells of *Limopsis*, as limopsids are usually par-

tially exposed on sea bottom level (Kondo, 1989), thus this small mussel utilizes them as an attachment substratum.

***Dacrydium minimum* Okutani and Izumidate, 1992** [Jn: Mijin-hibarigai] (Fig. 3M)

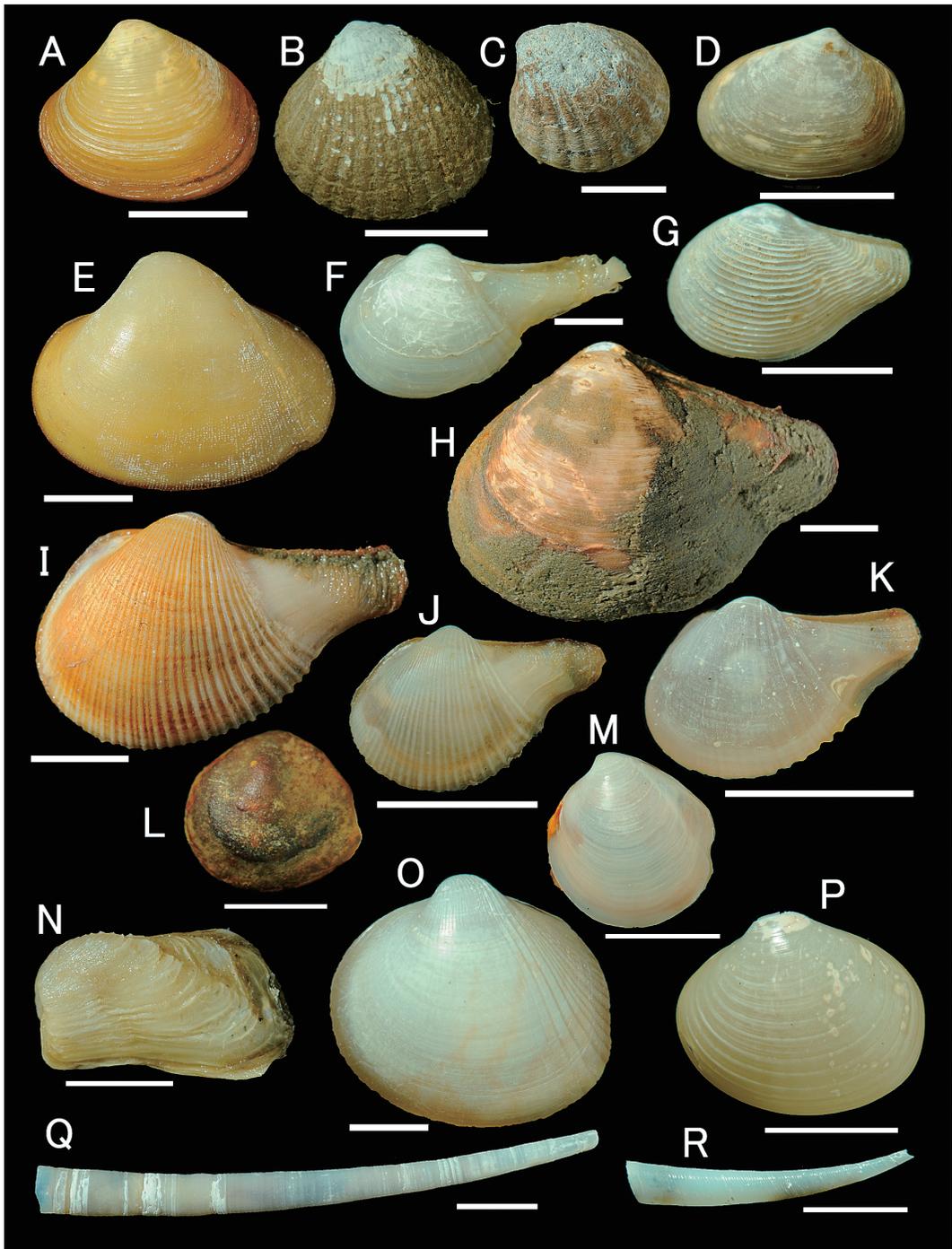
*Material examined.* St. N-4 (1: 1.0 mm), NSMT-Mo 81057.

*Remarks.* The present specimen is identifiable to the minute species originally described from the Yamato-tai Bank, central Sea of Japan, at a depth of 400–1200 m. A sole finding in this survey is from off Noto Peninsula, 604–612 m depth (St. N-4). In describing *D. minimum*, Okutani and Izumidate (1992) stated that *D. vitreum* (Möller, 1842) has less advanced anterior margin, far stronger and more numerous teeth on posterior arch (Warén, 1991). But, Kamenev (2013) synonymized *D. minimum* with a circum-boreal species, *D. vitreum* (Möller, 1842), probably because of such minor differences are attributable to the size of local specimens examined. However, Coan *et al.* (2000) mentioned that *D. vitreum* is limited to “the Arctic Ocean, the Arctic Atlantic, the Bering Sea, and Siberia”. Thus, they treated *D. minimum* as a synonym of *D. vitreum* with a question mark.

***Musculus minutus* Scarlato, 1960** [Jn: Kitano-kotamaégai] (Fig. 3N)

*Material examined.* St. M-3 (19: 4.8–6.8 mm), NSMT-Mo 81058; St. T-4 (10: 2.7–3.8 mm), NSMT-Mo 81059; St. T-5 (28: 3.0–4.8 mm), NSMT-Mo 81060; St. N-3 (9: 3.7–5.9 mm), NSMT-Mo 81061; St. N-4 (5: 3.0–5.9 mm), NSMT-Mo 81062.

Fig. 3. A, *Acila mirabilis*, NSMT-Mo 81001; B, *A. mirabilis*, young, NSMT-Mo 81003; C, *Ennucla tenuis*, NSMT-Mo 81004; D, *Nuculana robai*, NSMT-Mo 81018; E, *Nuculana acinacea*, NSMT-Mo 81030; F, G, *Megayoldia toyamaensis*, 81037; H, *Megayoldia toyamaensis*, young, NSMT-Mo 81034; I, *Yoldiella kibi*, NSMT-Mo 81044; J, *Limopsis tokaiensis*, NSMT-Mo 81052; K, *Limopsis kurilensis*, NSMT-Mo 81053; L, *Modiolus margaritaceus*, NSMT-Mo 81056; M, *Dacrydium minimum*, NSMT-Mo 81057; N, *Musculus minutus*, NSMT-Mo 81058; O, *Chlamys chosenica*, NSMT-Mo 81063; P, *Delectopecten vancouverensis*, NSMT-Mo 81070; Q, *Parvamussium alaskense*, NSMT-Mo 81073. Scales for A, D, F, G, J, O–Q: 5 mm; B, C, E, H, K, L, N: 2 mm; I, M: 1 mm.



*Remarks.* This species has been known from the Sea of Okhotsk to the northeastern Honshu, at the depth from 30 to 150m (Scarlato, 1981; Kurozumi, 2000).

**Order Pectinoidea**  
**H. Adams and A. Adams, 1857**  
 Family Pectinidae Rafinesque, 1815

***Chlamys (Chlamys) chosenica* Kuroda, 1932**

[Jn: Chosén-nishiki]

(Fig. 3O)

*Material examined.* St. M-1 (1: 20.6 mm), NSMT-Mo 81063.

*Remarks.* The original description by Kuroda (1932) based on the specimens collected from Seishin (Ch'ongjin), North Korea, was in Japanese, which may be translated: "Shell large. Left valve with five pale radial bands. Right valve pinkish white. Radial ribs frequently bifurcated or trifurcated on marginal area, also intercalated by secondary riblets between primary ribs. Primary ribs 25. Hinge line slanting. 66 × 55 mm, width 18 mm, hinge line length 31 mm." The original description by Kuroda (1932) and subsequent description (Hayami, 2000) agree well with a single specimen in the present material. Habe (1977) described its distribution range as "The Sea of Japan and Hokkaido", but Higo *et al.* (1999) reported that this species extends to the Pacific coast of northeastern Honshu.

***Chlamys* sp.**

*Material examined.* St. N-1 (1: 6.0 mm), NSMT-Mo 81064.

*Remarks.* We believe this to be a member of *Veprichlamys*, but it was difficult to identify a single tiny juvenile scallop to the genus or species level.

***Delectopecten vancouverensis* (Whiteaves, 1893)** [Jn: Ō-hari-nadéshiko]

(Fig. 3P)

*Material examined.* St. E-2 (4: 10.9–15.8 mm), NSMT-Mo 81065; St. M-5 (2: 6.0, 7.3 mm), NSMT-Mo 81066; St. M-6 (52: 2.8–14.2 mm),

NSMT-Mo 81067; St. T-3 (1: 8.7 mm), NSMT-Mo 81068; St. N-3 (1: 4.6 mm), NSMT-Mo 81069; St. N-4 (12: 5.2–17.2 mm), NSMT-Mo 81070; St. K-5 (20: 4.9–13.7 mm), NSMT-Mo 81071.

*Remarks.* This species has been called *Delectopecten randolphi* (Dall, 1897) by many past workers, but Coan *et al.* (2000) claimed that *D. randolphi* (Dall, 1897) falls a synonym of this species. This is widely distributed in circum-subarctic area from west coast of North America to the northern Japan as far south to Sagami Bay (Okutani, 1968) and western Sea of Japan Sea via Bering Sea and Okhotsk Sea (Habe, 1977; Scarlato, 1981; Higo *et al.*, 1999; Coan *et al.*, 2000; Okutani and Saito, 2014 all as *D. randolphi*).

## Family Propeamussiidae Abbott, 1954

***Parvamussium alaskense* (Dall, 1871)** [Jn: Arasuka-nishiki]

(Fig. 3Q)

*Material examined.* St. E-1 (12: 4.7–19.6 mm), NSMT-Mo 81072; St. M-1 (113: 7.8–19.1 mm), NSMT-Mo 81073; St. K-3 (167: 11.0–22.5 mm), NSMT-Mo 81074.

*Remarks.* During the present survey, two large patches (St. M-1: 156–166 m, and K-3: 370–400 m) were collected.

## Subclass Heterodonta Neumayr, 1883

## Order Carditoida Dall, 1889

## Family Astartidae d'Orbigny, 1844

Fig. 4. A, *Astarte hakodatensis*, NSMT-Mo 71075; B, *Cyclocardia rjabiniinae*, NSMT-Mo 81076; C, *Cyclocardia crassidens*, NSMT-Mo 81077; D, *Trigonothracia pusilla*, NSMT-Mo 81078; E, *Poromya castanea*, NSMT-Mo 81086; F, *Cuspidaria macrorhyncha*, NSMT-Mo 81089; G, *Cuspidaria ascoldica*, NSMT-Mo 81090; H, *Cuspidaria trosetes*, NSMT-Mo 81095; I, *Cardiomya behringensis*, NSMT-Mo 81106; J, *Cardiomya tosaensis*, NSMT-Mo 81108; K, *Cardiomya gouldiana*, NSMT-Mo 81114; L, *Mendicula ferruginosa*, NSMT-Mo 81117; M, *Thyasira tokunagai*, NSMT-Mo 81123; N, *Hiatella orientalis*, NSMT-Mo 81129; O, *Fulvia hungerfordi*, NSMT-Mo 81130; P, *Liocima fluctuosum*, NSMT-Mo 81131; Q, *Laevidentalium toyamaense*, NSMT-Mo 81132; R, *Dischides belcheri*, NSMT-Mo 81133. Scales for A–E, H–K, M, N, P–R: 5 mm; for F, G, L, O: 2 mm.

***Astarte hakodatensis* Yokoyama, 1920** [Jn:

Hakodate-shiraogai]

(Fig. 4A)

*Material examined.* St. M-3 (55: 4.3–12.6 mm), NSMT-Mo 81075.

Family Carditidae J. Fleming, 1828

***Cyclocardia rjabini* Scarlato, 1955** [Jn:

Erimo-marufumigai]

(Fig. 4B)

*Material examined.* St. K-2 (6: 5.2–8.7 mm), NSMT-Mo 81076.

*Remarks.* This species is superficially close to *C. ferruginea* (Clessin, 1888) in having about 25 radial ribs. It differs from that species in having less pronouncedly prosogyrous beaks, and a less convex ventral margin with an angulated posterior margin generating sub-quadrate profile. According to Scarlato (1981), *C. erimoensis* Tiba, 1972 is a synonym.

This species was previously discovered from a depth of 170 m off Shimane Prefecture (Okutani and Saito, 2014), and the present occurrence (St. K-2, 203–204 m depth) is nearby locality to the previous finding. *C. rjabini* is a subarctic species distributed from the Kamchatka, Okhotsk Sea to Hokkaido, southward to the present locality (western Sea of Japan).

***Cyclocardia crassidens* (Broderip and Sowerby, 1829)** [Jn: Kagami-marufumigai]

(Fig. 4C)

*Material examined.* St. M-1 (1: 9.0 mm), NSMT-Mo 81077.

**Order Anomalodesmata Dall, 1889**

Family Thraciidae Stoliczka, 1870

***Trigonothracia pusilla* (Gould, 1861)** [Jn:

Nomura-suémonogai]

(Fig. 4D)

*Material examined.* St. M-1 (1: 7.6 mm), NSMT-Mo 81078; St. M-3 (1: 7.5 mm), NSMT-Mo 81079.

Family Poromyidae Dall, 1886

***Poromya castanea* Habe, 1952** [Jn: Kuriiro-sunamegai]

(Fig. 4E)

*Material examined.* St. E-2 (4: 4.1–8.7 mm), NSMT-Mo 81080; St. E-3 (7: 4.7–12.8 mm), NSMT-Mo 81081; St. M-4 (7: 6.9–14.9), NSMT-Mo 81082; St. M-5 (5: 6.3–8.1 mm), NSMT-Mo 81083; St. T-3 (13: 4.5–9.4 mm), NSMT-Mo 81084; St. T-4 (1: 5.0 mm), NSMT-Mo 81085; St. N-3 (26: 3.9–17.0 mm), NSMT-Mo 81086; St. N-4 (1: 5.2 mm), NSMT-Mo 81087; St. K-3 (5: 11.3–14.6 mm), NSMT-Mo 81088.

*Remarks.* This species was ranked third 'most frequent' species in the previous investigation in the western sector of the Sea of Japan (Okutani and Saito, 2014), which included the type locality of this species (R/V *Soyo-maru* St. 499, off Oki Islands), near T/S *Tanshu-maru* St. TS09-N220. The distribution range of this species by Higo *et al.* (1999) is from Sado Island, southwards to the East China Sea coast of Kyushu and Yellow Sea, 30–350 m depth. Kamenev (2013) recorded this species from the eastern Sea of Japan. The present survey also made its range extended up north to off Esashi, west coast of Hokkaido. The deepest occurrence in this survey is 1040–1080 m (St. M-5).

Family Cuspidariidae Dall, 1886

***Cuspidaria macrorhyncha* E.A. Smith, 1895**

[Jn: Enaga-shakushi]

(Fig. 4F)

*Material examined.* St. T-2 (1: 8.2 mm), NSMT-Mo 81089.

***Cuspidaria ascoldica* Scarlato, 1972** [Jn: Mijin-shakushi]

(Fig. 4G)

*Material examined.* St. E-1 (9: 3.0–4.4 mm), NSMT-Mo 81090; St. E-3 (1: 2.5 mm), NSMT-Mo 81091.

*Remarks.* *Cuspidaria sadoensis* Okutani and Ito, 1983 is a synonym.

***Cuspidaria (Nordoneaera) trosaeetes* Dall, 1925**

[Jn: Atsu-shakushi]

(Fig. 4H)

*Material examined.* St. M-4 (10: 6.7–29.7 mm), NSMT-Mo 81092; St. T-3 (10: 7.4–12.4 mm), NSMT-Mo 81093; St. T-4 (7: 5.8–30.8 mm), NSMT-Mo 81094; St. T-5 (5: 19.3–4.8 mm), NSMT-Mo 81095; St. N-3 (1: 18.2 mm), NSMT-Mo 81096; St. N-4 (12: 5.3–28.4 mm), NSMT-Mo 81097; St. K-3 (5: 6.6–13.3 mm), NSMT-Mo 81098; St. K-4 (4: 4.0–9.3 mm), NSMT-Mo 81099.

***Cardiomya behringiana* (Leche, 1883) [Jn:**

Tengu-shakushi]

(Fig. 4I)

*Material examined.* St. E-3 (9: 6.1–14.5 mm), NSMT-Mo 81100; St. M-3 (21: 6.0–21.8 mm), NSMT-Mo 81101; St. M-4 (17: 5.2–20.4 mm), NSMT-Mo 81102; St. M-5 (17: 2.5–12.1 mm), NSMT-Mo 81103; St. T-5(1: 24.8 mm), NSMT-Mo 81104; St. N-3 (1: fractured), NSMT-Mo 81105; St. K-2 (5: 15.4–19.0 mm), NSMT-Mo 81106; St. K-4 (27: 3.9–7.1 mm), NSMT-Mo 81107.

***Cardiomya tosaensis* Kuroda, 1948 [Jn: Tosa-**

himéshakushi]

(Fig. 4J)

*Material examined.* St. K-2 (1: 7.9 mm), NSMT-Mo 81108; St. K-3 (1: 7.4 mm), NSMT-Mo 81109.

*Remarks.* *C. sagamiana* Okutani and Sakurai, 1964 is a synonym.

***Cardiomya gouldiana* (Hinds, 1843) [Jn: Himé-**

shakushi]

(Fig. 4K)

*Material examined.* St. E-3 (4: 4.1–6.3 mm), NSMT-Mo 81110; St. T-3 (15: 3.9–8.6 mm), NSMT-Mo 81111; St. T-4 (14: 5.0–9.7 mm), NSMT-Mo 81112; St. T-5 (6: 4.0–8.1 mm), NSMT-Mo 81113; St. N-3 (16: 4.4–10.2 mm), NSMT-Mo 81114; St. N-4 (12: 5.3–11.9 mm), NSMT-Mo 81115; St. K-4 (27: 4.1–9.8 mm), NSMT-Mo 81116.

**Order Veneroida****H. Adams and A. Adams, 1856**

Family Thyasiridae Dall, 1900

***Mendicula ferruginosa* (Forbes, 1844) [Jn:**

Sabitsuki-hanashigai]

(Fig. 4L)

*Material examined.* St. E-4 (71: 1.5–3.6 mm), NSMT-Mo 81117; St. M-4 (58: 1.1–3.2 mm), NSMT-Mo 81118; St. T-3 (9: 2.4–3.7 mm), NSMT-Mo 81119; St. N-3 (13: 2.2–2.6 mm), NSMT-Mo 81120; St. N-4 (12: 1.8–2.5 mm), NSMT-Mo 81121; St. K-4 (20: 1.5–3.1 mm), NSMT-Mo 81122.

*Remarks.* Kamenev (2013) synonymized *Axinopsis rubiginosa* Okutani and Izumidate, 1992 with this Arctic and circum-boreal species.

***Thyasira tokunagai* Kuroda and Habe in Habe, 1951 [Jn: Hanashigai]**

(Fig. 4M)

*Material examined.* St. T-5 (1: 6.9 mm), NSMT-Mo 81123; St. K-5 (1: 5.3 mm), NSMT-Mo 81124.

*Remarks.* Kuroda and Habe (1951) proposed this taxon name as a new name for *T. gouldi* Philippi of Yabe and Nomura (1925). Coan *et al.* (2000) considered this to be a new species, although Kuroda and Habe (*loc. cit.*) did not give the full description. This species has more prominent posterior auricle delimited by deep sulcus than in *T. flexuosa* (Montagu, 1803)

Family Hiattellidae J.E. Gray, 1824

***Hiatella orientalis* (Yokoyama, 1920) [Jn: Kinu-**

matoigai]

(Fig. 4N)

*Material examined.* St. E-1 (1: 5.6 mm), NSMT-Mo 81125; St. M-2 (1: 8.8 mm), NSMT-Mo 81126; St. M-3 (2: 7.6, 8.6 mm), NSMT-Mo 81127; St. T-1 (1: 8.5 mm), NSMT-Mo 81128; St. N-1 (6: 8.0–16.6 mm), NSMT-Mo 81129.

*Remarks.* In spite of the fact that trawl sampling was made on soft sand/mud bottom, this species is occasionally found byssally attached

on wooden debris, pebbles and other hard objects among the bottom sediment.

Family Cardiidae Lamarck, 1809

***Fulvia hungerfordi* (Sowerby, 1901)** [Jn: Chigo-torigai]  
(Fig. 4O)

*Material examined.* St. K-2 (1: 6.9 mm), NSMT-Mo 81130.

Family Veneridae Rafinesque, 1815

***Liocyma fluctuosum* (Gould, 1841)** [Jn: Ezo-hamaguri (= Hososuji-hamaguri)]  
(Fig. 4P)

*Material examined.* St. M-3 (61: 3.7–9.1 mm), NSMT-Mo 81131.

**Class SCAPHOPODA Bronn, 1862**

Order Dentaliida Starobogatov, 1974

Family Laevidentaliidae Palmer, 1974

***Laevidentalium toyamaense* (Kuroda and Kikuchi, 1933)** [Jn: Toyama-tsunogai]  
(Fig. 4Q)

*Material examined.* St. K-2 (12: 16.7–35.0 mm), NSMT-Mo 81132.

*Remarks.* The majority of the present lot is in poor condition as the shell of this species is so fragile.

Order Gadilida Starobogatov, 1974

Family Gadilidae Steiner, 1992

***Dischides belcheri* (Pilsbry and Sharp, 1898)**  
[Jn: Futamata-tsunogai]  
(Fig. 4R)

*Material examined.* St. E-3 (76: 9.0–14.5 mm), NSMT-Mo 81133.

**Discussion**

Within the R/V *Tansei-maru* collection, 31

species of bivalves and two scaphopod species were identified. Three species were recorded for the first time from the Sea of Japan, namely, *Nuculana acinacea* Habe, 1958, *Limopsis kurilensis* Scarlato, 1981, and *Musculus minutus* Scarlato, 1960.

The most frequent species among them was *Nuculana robai* (16 stations, 204–1564 m), followed by *Megayoldia toyamaensis* (10 stations, 204–802 m) and *Ennucula tenuis* (9 stations, 204–1080 m). Particularly, *M. toyamaensis* yielded various growth stages (SL 3.6 mm to 29.6 mm: e.g. at Sts. T-3 and T-4) that are traceable a shell transformation with growth. The most abundant species was *Acila mirabilis* (1070 specimens from 3 stations, 204–443 m) followed by *Nuculana robai* (813 specimens) and *Parvamussium alaskense* (292 specimens from 3 stations, 152–411 m). *A. mirabilis* seems to be more concentrated in the western sector of the Sea of Japan, while *N. robai* is likely scattered throughout the surveyed area. Because of sparse distribution of sampling stations, it is difficult to discuss the distribution pattern and relative abundance of every species under study: There are 12 species occurring from a single station, and 6 species from only two stations.

As was already discussed in the previous paper on the T/V *Tanshu-maru* collection (Okutani and Saito, 2014), 31 bivalves in the present material is likewise classifiable into three major “elements”, namely, (1) Subarctic cold water (+ circumboreal) elements, (2) Endemic elements, (3) Temperate/intermediate-water elements, and (4) Unknown, in spite of the fact that the geographical coverage of the present survey is far broader than the previous R/V *Tanshu-maru* survey. The element (1) includes 13 species, such as, *Ennucula tenuis*, *Nuculana robai*, *Limopsis kurilensis*, *Musculus minutus*, *Delectopecten vancouverensis*, *Parvamussium alaskense*, *Astarte hakodatensis*, *Cyclocardia rjabiniinae*, *Cyclocardia crassidens*, *Cuspidaria ascoldica*, *Cardiomya behringensis*, *Mendicula ferruginosa*, and *Liocyma fluctuosa*, to the element (2) 5 species, namely, *Megayoldia toyamaensis*, *Dac-*

*rydium minimum*, *Chlamys chosenica*, *Poromya castanea*, and *Cuspidaria trosaeetes* may belong, while the element (3) contains 12 species, namely, *Acila mirabilis*, *Nuculana acinacea*, *Yoldiella kibi*, *Limopsis tokaiensis*, *Modiolus margaritaceus*, *Trigonothracia pusilla*, *Cuspidaria macrorhyncha*, *Cardiomya tosaensis*, *Cardiomya gouldiana*, *Thyasira tokunagai*, *Hiatella orientalis*, and *Fulvia hungerfordi*, and element (4) one unidentifiable species, *Chlamys* sp. Thus, elements (1), (2), (3) and (4) represent 41.9%, 16.1%, 38.7% and 3.2%, respectively. For comparison, the equivalent values of the previous survey (Okutani and Saito, 2014) were 27.6%, 13.8%, 51.7%, and 6.9%, respectively.

Lutaenko and Noseworthy (2013) analyzed zonal-geographical compositions of bivalve faunas in several bays along the coast of Primorye and three more larger regions. The constituent proportions of shallow water coastal domains of Primorye shows a considerable bias from those values obtained by the R/V *Tansei-maru* collection of shelf to bathyal bivalves.

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### Appendix I: Occurrence of species by R/V *Tansei-maru* KT-11-9 stations.

- Musashi-tai Bank, northern Sea of Japan.
- St. M-1 (156–166 m): *Chlamys chosonenica* (1); *Parvamsium alaskaense* (113); *Cyclocardia crassidens* (1); *Trigonothracia pusilla* (1).
- St. M-2 (200–206 m): *Limopsis tokaiensis* (1); *Hiatella orientalis* (1).
- St. M-3 (411–407 m): *Ennucula tenuis* (44); *Nuculana robai* (268); *Megayoldia toyamaensis* (1); *Limopsis tokaiensis* (1); *Musculus minuta* (19); *Astarte hakodatenensis* (55); *Trigonothracia pusilla* (1); *Hiatella orientalis* (2); *Liocyma fluctuosum* (61); *Cardiomya behringensis* (21).
- St. M-4 (616–627 m): *Ennucula tenuis* (30); *Nuculana robai* (144); *Yoldiella kibi* (24); *Mendicula ferruginosa* (58); *Poromya castanea* (7); *Cuspidaria trosetes* (10); *Cardiomya behringensis* (14).
- St. M-5 (1040–1080 m): *Ennucula tenuis* (1); *Nuculana robai* (1); *Delectopecten vancouverensis* (2); *Poromya castanea* (5); *Cardiomya behringensis* (17).
- St. M-6 (1485–1821 m): *Delectopecten vancouverensis*

(52).

Off Esashi, west coast of Oshima Peninsula, Hokkaido

St. E-1 (246–222 m): *Nuculana robai* (1); *Limopsis kuriensis* (5); *Parvamussium alaskense* (12); *Hiatella orientalis* (1); *Cuspidaria ascondica* (9).St. E-2 (460–538 m): *Nuculana robai* (11); *Delectopecten vancouverensis* (4); *Poromya castanea* (4).St. E-3 (605–563 m): *Nuculana robai* (214); *Megayoldia toyamaensis* (1); *Yoldiella kibi* (2); *Poromya castanea* (7); *Cuspidaria ascondica* (1); *Cardiomya behringensis* (9); *Cardiomya gouldiana* (4); *Dischides belcheri* (76).St. E-4 (831–802 m): *Nuculana robai* (2); *Megayoldia toyamaensis* (juv. 1); *Yoldiella kibi* (1); *Mendicula ferruginosa* (71).

Toyama Bay.

St. T-1 (162–173 m): *Modiolus margaritaceus* (1); *Hiatella orientalis* (1).St. T-2 (230–258 m): *Acila mirabilis* (340); *Limopsis tokaiensis* (1); *Cuspidaria macrorhyncha* (1).St. T-3 (396–443 m): *Acila mirabilis* (14); *Ennucula tenuis* (14); *Nuculana robai* (28); *Megayoldia toyamaensis* (34); *Yoldiella kibi* (26); *Delectopecten vancouverensis* (1); *Mendicula ferruginosa* (9); *Poromya castanea* (13); *Cuspidaria trossetes* (10); *Cardiomya gouldiana* (15).St. T-4 (569–574 m): *Ennucula tenuis* (1); *Nuculana robai* (51); *Megayoldia toyamaensis* (24); *Musculus minuta* (10); *Poromya castanea* (1); *Cuspidaria trossetes* (7); *Cardiomya gouldiana* (14).St. T-5 (795–790 m): *Nuculana robai* (18); *Megayoldia toyamaensis* (7); *Yoldiella kibi* (6); *Musculus minuta* (28); *Thyasira tokunagai* (1); *Cuspidaria trossetes* (5); *Cardiomya behringensis* (1); *Cardiomya gouldiana* (6).St. T-6 (1410–1564 m): *Nuculana robai* (1).

North off Noto Peninsula

St. N-1 (160–157 m): *Nuculana acinacea* (1); *Modiolus margaritaceus* (2); *Chlamys* sp. (1); *Hiatella orientalis* (6).St. N-2 (201–203 m): *Nuculana robai* (1).St. N-3 (402–414 m): *Ennucula tenuis* (8); *Nuculana robai* (36); *Megayoldia toyamaensis* (25); *Yoldiella kibi* (9); *Musculus minuta* (9); *Delectopecten vancouverensis* (1); *Mendicula ferruginosa* (13); *Poromya castanea* (26); *Cuspidaria trossetes* (1); *Cardiomya behringensis* (1); *Cardiomya gouldiana* (16).St. N-4 (621–604 m): *Ennucula tenuis* (1); *Megayoldia toyamaensis* (juv.17); *Yoldiella kibi* (9); *Dacrydium minimum* (1); *Musculus minuta* (5); *Delectopecten vancouverensis* (12); *Mendicula ferruginosa* (12); *Poromya castanea* (1); *Cuspidaria trossetes* (12); *Cardiomya gouldiana* (14).

Off Kasumi, Hyogo Prefecture.

St. K-1-2 (142–144 m): *Modiolus margaritaceus* (16).St. K-2 (203–204 m): *Acila mirabilis* (716); *Ennucula tenuis* (7); *Nuculana robai* (17); *Megayoldia toyamaensis* (10); *Cyclocardia rjabiniinae* (6); *Cardiomya behringensis* (5); *Cardiomya tosaensis* (1); *Fulvia hungerfordi* (1); *Laevidentalium toyamaense* (12).St. K-3 (400–370 m): *Ennucula tenuis* (1); *Nuculana robai* (18); *Nuculana acinacea* (10); *Megayoldia toyamaensis* (2); *Parvamussium alaskaense* (167); *Poromya castanea* (5); *Cuspidaria trossetes* (5); *Cardiomya tosaensis* (1).St. K-4 (603–613 m): *Nuculana robai* (2); *Yoldiella kibi* (2); *Cuspidaria trossetes* (4); *Cardiomya gouldiana* (27); *Mendicula ferruginosa* (20).St. K-5 (1288–1277 m): *Yoldiella kibi* (17); *Delectopecten vancouverensis* (20); *Thyasira tokunagai* (1).